

The University of Chicago

THE PREPARATION AND
PROPERTIES OF N-DERIVATIVES OF
1-AMINO-2-METHYL-6-PHENYL-
HEXATRIENE-1,3,5

A DISSERTATION SUBMITTED TO THE
FACULTY OF THE DIVISION OF THE
PHYSICAL SCIENCES IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF CHEMISTRY

1939

By

WILL SCOTT DeLOACH

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INTRODUCTION

The similarities between the reactions and the reactivities of the benzene nucleus and those of the terminally phenylated conjugated polyenes are well known. Hydrogen bromide does not add to the double bonds of benzene, neither does it add to the double bonds of diphenyl butadiene.¹ Benzene is not attacked by cold alkaline permanganate, and diphenyl hexatriene is oxidized only very slowly under the same conditions.² Benzene reacts very slowly with bromine; diphenyl hexatriene adds one mole of bromine to form an unstable dibromide.

Considering all of these facts, it was thought that a compound like 1-amino-6-phenyl-hexatriene-1,3,5 ($C_6H_5CH=CH-CH=CH-CH=CH-NH_2$) which contains a conjugated hexatriene chain which is in turn conjugated with the double bonds of a benzene nucleus, might be stable in the amine rather than in the imine form. If this were actually the case, the amine might be expected to have some properties closely related to those of the aromatic amines. For instance, diazotization followed by coupling or by replacement of the diazonium group by a halogen or cyanide group might be possible.

Attempts to prepare enamines have resulted variously in the formation of the corresponding ketimine, a tautomeric system of the enamine $\rightleftharpoons$ ketimine type, or a cyclic imine. Gabriel³ prepared what he considered to be vinylamine, $CH_2=CH-NH_2$, but Marckwald⁴ showed that it was dimethylene imine, $\overline{CH_2-CH_2}NH$. In studying the catalytic reduction of α,β -unsaturated nitro compounds, Kohler and Drake⁵ found that β,β -diphenyl-nitro-ethylene

¹Hinrichsen, Ann., 336, 189 (1904); Zincke and Muhlhausen, Ber., 38, 757 (1905).

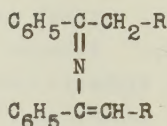
²Kuhn and Winterstein, Helv. Chim. Acta, 11, 87 (1928).

³Gabriel, Ber., 21, 1049 (1888); Gabriel and Stelzner, Ber., 28, 2929 (1895).

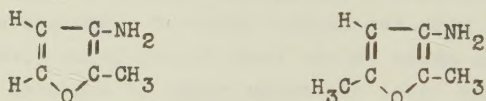
⁴Marckwald, Ber., 33, 764 (1900); Howard and Marckwald, Ber., 32, 2031 (1899).

⁵Kohler and Drake, J. Am. Chem. Soc., 45, 1287 (1923).

was reduced to diphenyl-acetaldimine. Moureu and Mignonac¹ prepared many ketimines of the type $RR'C=NH$, where R is aromatic and R' is either aromatic or aliphatic. It was noted that the compounds having no hydrogen atom on a carbon adjacent to the $C=NH$ group were stable, while those compounds having a hydrogen atom in this position were unstable. The unstable ketimines liberated ammonia and formed the so-called isoketimines of the type:



The preparation of 1-phenyl-4-amino-butadiene has been reported in very low yields by Muskat and Grimsley,² but no mention was made of the properties of the amino group other than the statement that the compound existed in the amine form. The simple 3-amino furans:



have been prepared and studied by Stevenson and Johnson.³ These compounds were found to be quite sensitive to the action of hot aqueous acids and alkalies. For example, 2-methyl-3-amino-furan was rapidly hydrolysed by hot dilute sulfuric acid, with almost quantitative elimination of ammonia. It was believed that these compounds are tautomeric systems of the enamine $\rightleftharpoons$ ketimine type, with the ketimine predominating.

In this investigation, the preparation of 1-amino-2-methyl-6-phenyl-hexatriene-1,3,5 ($C_6H_5CH=CH-CH=CH-C(CH_3)=CH-NH_2$) was attempted. This compound was chosen because of the fact that it was simpler to build up this chain than to build the corresponding chain without the methyl group. Although several N derivatives of the amine were prepared, the amine itself was never isolated. The general plan of attack was to prepare some derivative of the amine and to attempt to hydrolyse that and thus iso-

¹Moureu and Mignonac, Ann. Chim., (9) 14, 322 (1920).

²Muskat and Grimsley, J. Am. Chem. Soc., 55, 3762 (1933).

³Stevenson and Johnson, J. Am. Chem. Soc., 59, 2525 (1937).

late either the free amine or a salt of the amine. The following compounds were prepared (as summarized in the numbered chart below) in the course of the investigation:

- I. $C_6H_5CH=CH-CH=CH-C(CH_3)=CH-CO-NHNH_2$
- II. $C_6H_5CH=CH-CH=CH-C(CH_3)=CH-CO-N_3$
- III. $C_6H_5CH=CH-CH=CH-C(CH_3)=CH-NH-CO_2C_2H_5$
- IV. $C_6H_5CH=CH-CH=CH-C(CH_3)=CH-NH-CO-C_6H_5$
- V. $C_6H_5CH=CH-CH=CH-C(CH_3)=CH-NH-CO-NH-CH=C(CH_3)-CH=CH-CH=CH-C_6H_5$
- VI. $C_6H_5CH=CH-CH=CH-C(CH_3)=CH-CO-NHOH$

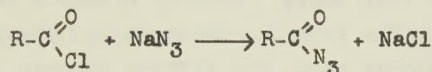
In most of these preparations the yields were low (below 20 per cent), and in some of them, very low (approximately 5 per cent). In particular, the yields of the hydrazide(I) were seldom above 10 per cent and never above 22 per cent. Since the hydrazide was used in the preparation of the compounds, except the hydroxamic acid(VI), the result was that only small quantities of those compounds were available for the investigation.

The starting material was the methyl ester of 1-carboxy-2-methyl-6-phenyl-hexatriene-1,3,5 ($C_6H_5CH=CH-CH=CH-C(CH_3)=CH-COOCH_3$). This compound was prepared by means of the Reformatsky reaction between cinnamylidene acetone and methyl bromoacetate, as described by Kuhn and Hoffer.¹ The conditions were changed somewhat so as to give a better yield of the ester (30-35 per cent as compared to 12 per cent), and it was never found that the reaction proceeded slowly, as reported.

By heating this ester in absolute alcohol solution with absolute hydrazine hydrate on the steam bath for 10-12 hours the corresponding hydrazide(I) was formed. The yields in this reaction were particularly low, frequently being below 10 per cent of the theoretical, and rarely as high as 20 per cent. This was very unfortunate, because the hydrazide had to be converted into the azide and then that in turn be rearranged to the isocyanate which was then converted into a derivative of the amine before actual isolation of the amine or an amine salt could be attempted. The result was that in the last steps of the series of reactions it was necessary to work with very small quantities of materials.

¹Kuhn and Hoffer, Ber., 65B, 651-60 (1932).

Many different conditions were used in an attempt to improve the yield of the hydrazide. Heating the reaction mixture to 130 resulted in general decomposition and, apparently, reduction of the ester by the hydrazine hydrate. Allowing an alcoholic solution of the reactants to stand at room temperature did not produce any of the desired product, nor did heating an alcohol solution of the hydrazine salt of the acid, $C_6H_5CH=CH-CH=CH-C(CH_3)=CH-COOH$. Generally, the best procedure was found to be to heat on the steam bath one mole of the ester with two moles of hydrazine hydrate and just enough alcohol to make a homogeneous solution. It would have been desirable to prepare the azide directly (and thus avoid the preparation of the hydrazide) by means of the reaction:



but several attempts to prepare the necessary acid chloride were not successful. The hydrazide was readily crystallized from absolute alcohol, from which it precipitated in the form of bright yellow needles. Occasionally, when not pure, it came out of solution as red platelets, but further recrystallization always produced the yellow needles. The melting points of various samples ranged from 156-61° to 171-73°. One sample that was recrystallized four times from alcohol melted at 168-70°. It is possible that the hydrazide, as prepared, consisted of a mixture of two stereoisomeric forms, because the ester from which the hydrazide is obtained yields, on hydrolysis, two acids that are geometrical isomers.¹ No attempt was made to determine whether or not two forms of the hydrazide actually were present.

The hydrazide was converted into the corresponding azide (II) by solution in 85 per cent acetic acid and treatment of the solution with an aqueous solution of sodium nitrite. The crude azide was rather difficult to dry thoroughly; because of its high instability it was not heated, nor was the desiccator in which it was placed evacuated. It was usually found to be dry after standing for three days over phosphorus pentoxide, the drying agent being changed twice daily. The azide crystallized as light yellow needles from dry ether-ligroin, M.P. 88-90°. Because of the difficulty in purification of the azide, and of the ease with which

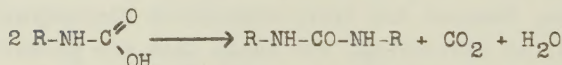
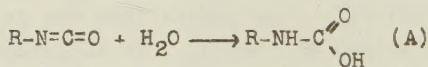
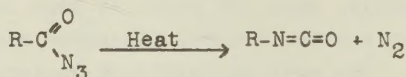
¹Kuhn and Hoffer, loc. cit.

it decomposed, a satisfactory analysis for nitrogen was not obtained.

The azide was converted into derivatives of the amine, $(C_6H_5CH=CH-CH=CH-C(CH_3)=CH-NH_2)$, by rearrangement to the corresponding isocyanate(VII) followed by treatment of that compound with the appropriate reagent. No attempt was made to isolate the isocyanate.

The urethane(III) was prepared by solution of the azide (II) in alcohol and boiling of the resulting solution. It was purified by crystallization from alcohol-water. When pure the urethane is a light yellow crystalline solid that melts at $151-52^\circ$. It undergoes some decomposition on standing at room temperature for three or four weeks. Several attempts were made to obtain the desired amine from the urethane by hydrolysis with concentrated hydrochloric acid, but without success.

The sym-di-substituted urea(V) was prepared by heating the azide in the presence of water, under an atmosphere of nitrogen. The reactions probably can be represented by the following scheme:



In carrying out this reaction it was necessary to heat the water very cautiously until the azide melted, otherwise the azide would decompose with almost explosive violence. The carbamic acid(A) was not isolated. The urea was found to be rather difficult to purify, but crystallization from ethyl acetate yielded a light tan solid, M.P. $209-10^\circ$, which was sufficiently pure for analysis.

The benzoyl derivative (IV) of the desired amine was prepared from the azide by means of the intermediate isocyanate. The azide was dissolved in a mixture of benzene and toluene and heated until nitrogen was no longer evolved, and this solution, which contained the isocyanate, was treated with an excess of phenyl magnesium bromide. The resulting compound of formula $C_6H_5CH=CH-CH=CH-C(CH_3)=CH-NH-CO-C_6H_5$ was purified by crystalliza-

tion from alcohol, and melted when pure at 191-92°. Unsuccessful attempts were made to hydrolyse this compound in both acidic and in basic solutions. One very important difficulty encountered in these attempts was the low solubility of the compound in water.

It was thought that perhaps the urethane(III) could be obtained more readily by means of the series of reactions:



than from the azide(II). The hydroxamic acid(VI) was prepared by treatment of the ester(VIII) with hydroxylamine in methyl alcohol solution. However, the yields in this step were so low that the plan was not continued. The hydroxamic acid is a very fluffy, light tan colored solid, M.P. 156-58°.

Preparation of the amide ($C_6H_5CH=CH-CH=CH-C(CH_3)=CH-CO-NH_2$) was attempted in order to try to convert it to the amine by means of the Hofmann degradation. It was realized that the conjugated double bond system in the amide would doubtless be attacked, but it was thought that some yield of the amine might be obtained. Several unsuccessful attempts were made to prepare the amide, from both the corresponding acid and from the ester(VIII).

(1) The acid(IX) was dissolved in an excess of thionyl chloride, the solution was heated for fifteen minutes and then the excess thionyl chloride was distilled off. The viscous red liquid which remained was dissolved in dry ether and dry ammonia was passed in until solid was no longer formed. The amide was not isolated from this solid.

(2) The acid(IX), dissolved in dry benzene, was heated with phosphorus trichloride and the solution which resulted was poured into concentrated ammonium hydroxide. The acid was recovered unchanged.

(3) The ester(VIII) was dissolved in absolute alcohol in a pressure bottle, the solution cooled to 0°, saturated with ammonia, and the bottle stoppered while cold. No precipitate formed when

this solution was allowed to stand for two weeks, nor was the amide obtained when the solvent was distilled off.

A number of unsuccessful attempts were made to prepare the amine by hydrolysis of the urethane(III), by hydrolysis of the benzoyl derivative(IV), and by treatment of the acid(IX) in sulfuric acid solution with hydrazoic acid.

The urethane was heated with concentrated hydrochloric acid on the steam bath and the resulting tar removed by filtration. The filtrate was made alkaline and was extracted with ether. The ether extract was dried and saturated with dry hydrogen chloride. No precipitate of amine hydrochloride was formed. The length of time that the urethane and hydrochloric acid were heated was varied, but the amine was never isolated.

It would have been desirable to hydrolyse the benzoyl derivative in an alkaline solution and to steam distil the amine as fast as it was formed. However, when this was tried, no amine was detected in the distillate. The benzoyl derivative was hydrolysed by refluxing with dilute sulfuric acid, the resulting solution was diluted with water and extracted with ether. The ether extract was dried and saturated with dry hydrogen chloride, but no precipitate formed. Since it is entirely possible that the amine ($\text{C}_6\text{H}_5\text{CH}=\text{CH}-\text{CH}=\text{CH}-\text{C}(\text{CH}_3)=\text{CH}-\text{NH}_2$) would exist as a tautomeric system of the enamine aldimine type, it is likely that the aldimine form was hydrolysed to an aldehyde as fast as it was liberated. The ether extract from the acid hydrolysis was tested for the presence of aldehyde, but no conclusive results were obtained.

The acid ($\text{C}_6\text{H}_5\text{CH}=\text{CH}-\text{CH}=\text{CH}-\text{C}(\text{CH}_3)=\text{CH}-\text{COOH}$) was dissolved in concentrated sulfuric acid and treated with a chloroform solution of hydrazoic acid. A small amount of aniline was isolated from the reaction mixture. The aniline was formed, probably, by the action of hydrazoic acid on the benzoic acid formed by oxidation of the acid(IX) by sulfuric acid. No other amine was found.

EXPERIMENTAL PART

A. Preparation of Cinnamylidene Acetone

Cinnamylidene acetone was prepared according to the method described by Diehl and Einhorn.¹

Eighty grams of acetone dissolved in 3,600 g. of water was shaken with 40 g. of cinnamaldehyde until an emulsion was formed, then 40 g. of 10 per cent sodium hydroxide solution was added and the mixture was allowed to stand for 48 hours, with shaking from time to time. The solid that formed was filtered off, washed with water, dried and crystallized from ether. M.P. 68°. The yields of pure ketone averaged about 55 per cent of the theoretical.

B. Preparation of Methyl Bromoacetate²

Bromoacetic acid was prepared by the method described by Ward,³ and then esterified with methyl alcohol.

Dry bromine (812 g.) was added to dry acetic acid (280 g.) in which was suspended dry red phosphorus (5.6 g.). The mixture was heated under reflux until all of the bromine had reacted. The product was then distilled at atmospheric pressure. The bulk of the bromoacetic acid was collected at 203°. The yield was about 80 per cent.

C. Preparation of the Methyl Ester of 1-Carboxy-2-Methyl-6-Phenyl-Hexatriene-1,3,5 (Compound VIII, p. 4)

The methyl ester of 1-carboxy-2-methyl-6-phenyl-hexatriene-1,3,5 was prepared as described by Kuhn and Hoffer.⁴

¹Diehl and Einhorn, Ber., 18, 2321 (1885).

²I wish to take this opportunity to express my appreciation for the assistance rendered me by T. R. Sherrod, who, on a National Youth Administration assignment, prepared the methyl bromoacetate used in this investigation, and performed the analyses for carbon and hydrogen on the new compounds prepared.

³Ward, J. Chem. Soc., 121, 1161 (1922).

⁴Kuhn and Hoffer, loc. cit.

Cinnamylidene acetone (76 g.) and methyl bromoacetate (76 g.) were dissolved in 225 cc. of anhydrous benzene and 35 g. of granular zinc (Baker's C.P. 20-30 mesh) added. The mixture, in a 500 cc. round bottom flask fitted with a reflux condenser and protected from the moisture of the air with a calcium chloride tube, was heated on a hot plate until the reaction started. Then the source of heat was removed until the reaction ceased, after which the contents of the flask were heated to boiling for five minutes. The reaction mixture was cooled to 0° and shaken with three 100 cc. portions of cold 20 per cent sulfuric acid, then washed with ice water until the washings were no longer acid to litmus. The benzene solution was dried with anhydrous sodium sulfate, the benzene distilled off at reduced pressure, and finally the ester was distilled at 3 mm., the fraction that came over at $160-85^{\circ}$ was collected. The yield of crude ester was usually 25-35 per cent of the theoretical. The ester was not purified further before use.

D. Preparation of the Hydrazide of 1-Carboxy-2-Methyl-6-Phenyl-Hexatriene-1,3,5 (Compound I, p. 4)

The ester(VIII) (36 g.), absolute hydrazine hydrate (Kahlbaum, 18 g.), and absolute alcohol (30 cc.) were placed in a 200 cc. round bottom flask fitted with a reflux condenser, and protected from moisture of the air with a calcium chloride tube. The contents of the flask were heated on the steam bath for 11 hours, and then cooled; a heavy precipitate of orange colored crystals appeared. The solid was brought on to a Buchner funnel and washed several times with dry ether. The filtrate was concentrated on the steam bath, and then heated as before for 10 hours and a second, much smaller, crop of crystals was obtained. The crude hydrazide was crystallized from alcohol twice, and precipitated in the form of yellow needles. The best yield obtained in several preparations was 8.0 g. The highest percentage of the theoretical yield was 22 per cent. Melting point $163-67^{\circ}$.

Analysis--Calculated for $C_{14}H_{16}ON_2$:	C, 73.69%;	H, 7.02%;	N, 12.28%
Found	C, 73.83 ;	H, 6.87 ;	N, 12.47

E. Preparation of the Azide of 1-Carboxy-2-Methyl-6-Phenyl-Hexatriene-1,3,5 (Compound II, p. 4)

The hydrazide(I) (11.5 g.) was dissolved in 300 cc. of 86 per cent acetic acid and the solution was cooled to -3° . To the

stirred solution was added slowly about 25 g. of an ice cold 15 per cent solution of sodium nitrite. (The temperature was not allowed to rise above 0°.) After this amount had been added the solution turned starch-potassium iodide paper blue, indicating the presence of an excess of nitrous acid. Ice water (600 cc.) was added and the solution was allowed to stand for an hour and a half. The solid which formed in this time was transferred to a Buchner funnel and washed with ice water until the filtrate was no longer acid. The crude azide was dried by allowing it to stand for three days at room temperature, without vacuum, over phosphorus pentoxide. The compound was purified by boiling it with three 100 cc. portions of dry ether, each portion was filtered while hot. Approximately 1 g. of brownish material, M.P. 180-90°, did not dissolve in the ether. The filtrates were combined, dry ligroin was added and the solvents evaporated in a stream of dry nitrogen until a precipitate formed. The azide came down in the form of pale yellow needles, M.P. 88-90°. Several crops of crystals were obtained from the mother liquor. Total yield, 9.8 g. The percentage of the theoretical yield was 81 per cent.

Analysis--Calculated for $C_{14}H_{13}ON_3$: N, 17.59 per cent

Found : N, 16.73, 16.77

A satisfactory analysis was not obtained for this compound because of the fact that it is very unstable and difficult to purify.

F. Preparation of the Ethyl Urethane of 1-Amino-2-Methyl-6-Phenyl-Hexatriene-1,3,5 (Compound III, p. 4)

The azide(II) (9.8 g.) was placed in a 400 cc. beaker and about 200 cc. of absolute alcohol was poured over it. This mixture was heated on the steam bath until all of the solid was dissolved, and then was concentrated to about 50 cc. The solution was allowed to cool and the solid that formed was brought on a Buchner funnel and washed with a small amount of alcohol. A second crop of crystals was obtained by concentration of the mother liquor. The total yield was 9.0 g., M.P. 150°. The percentage of the theoretical yield was 85 per cent. On further recrystallization from alcohol-water the melting point rose to 151-52°. When pure the urethane is a light yellow crystalline solid, and undergoes some decomposition when allowed to stand at room temperature for three or four weeks.

Analysis--Calculated for $C_{16}H_{19}O_2N$: C, 74.71%; H, 7.39%; N, 5.45%
 Found C, 74.39 ; H, 7.40 ; N, 5.49

G. Preparation of the Sym-di-substituted Urea (Compound V, p. 4)

Two grams of crude azide was placed in a 250 cc. flask fitted with a reflux condenser, 75 cc. of freshly boiled distilled water was added, and nitrogen was passed through to sweep out the air. The mixture was heated cautiously until the azide melted, with evolution of gas, and then became solid again. The water was boiled for an hour, cooled and filtered, and the solid was dried in vacuo over sulfuric acid. The crude, dark brown urea was found to be rather difficult to purify by crystallization, but the use of ethyl acetate as a solvent resulted in a sample that gave a satisfactory analysis for nitrogen. The purified urea is light brown in color, but darkens on standing for 2 or 3 days. M.P. $209-10^{\circ}$.

Analysis--Calculated for $C_{27}H_{28}ON_2$: N, 7.07 per cent
 Found N, 7.35

H. Preparation of the Hydroxamic Acid of 1-Carboxy-2-Methyl-6-Phenyl-Hexatriene-1,3,5 (Compound VI, p. 4)

Hydroxylamine hydrochloride (2.8 g.) was dissolved in 30 cc. of methyl alcohol and to the solution so obtained was added a solution of 1 g. of sodium in 20 cc. of methyl alcohol. The liquid was filtered through glass wool in order to remove the precipitated sodium chloride. The filtrate was added to 10 g. of the methyl ester of 1-carboxy-2-methyl-6-phenyl-hexatriene-1,3,5, then 1 g. of sodium dissolved in 20 cc. of methyl alcohol was added and the resulting solution was allowed to stand overnight. The next morning a small amount of finely divided yellow solid was in the bottom of the flask. Most of the methyl alcohol was removed by distillation under reduced pressure. A yellow solid precipitated as the solvent was removed. This solution was filtered and the solid was washed with ether. This substance, the sodium salt of the hydroxamic acid, was dissolved in water and the resulting solution was acidified with dilute hydrochloric acid. A yellow precipitate was formed. The mixture was allowed to stand for four hours, then was filtered and the solid was washed with water and dried. The crude hydroxamic acid melted at $155-65^{\circ}$, with decomposition. Two recrystallizations from alcohol-water produced

the pure compound as very light platelets, pale tan in color, M.P. 156-58°. Yield of the pure substance was 0.3 g., which is 3 per cent of the theoretical.

Analysis--Calculated for $C_{14}H_{15}O_2N$: C, 73.36%; H, 6.55%; N, 6.11%
Found : C, 73.12 ; H, 6.62 ; N, 6.08

I. Preparation of the Benzoyl Derivative of 1-Amino-2-Methyl-6-Phenyl-Hexatriene-1,3,5 (Compound IV, p. 4)

One gram of the azide(II) was dissolved in a mixture of 20 cc. of dry benzene and 10 cc. of dry toluene. This solution was heated cautiously under an atmosphere of nitrogen until gas was no longer evolved, then it was cooled to 0° and added with stirring to an excess of phenyl magnesium bromide in ether solution, also cooled to 0°. The intermediate compound was hydrolysed with an excess of 15 per cent ammonium chloride and the benzoyl derivative was extracted with three 50 cc. portions of ether. The ether extracts were combined and dried with anhydrous sodium sulfate, and the solution concentrated to a small volume by distillation under reduced pressure. A yellow precipitate was formed as the solvents were removed. The crude benzoyl derivative was transferred to a Buchner funnel and washed with a small amount of alcohol. M.P. 185-87°. Three recrystallizations from alcohol resulted in the pure compound, M.P. 191-92°. Yield, 0.2 g. Percentage of the theoretical, 17 per cent.

Analysis--Calculated for $C_{20}H_{19}ON$: C, 83.04%; H, 6.57%; N, 4.84%
Found : C, 83.24 ; H, 6.86 ; N, 5.02

J. Attempts to Prepare the Amine 1-Amino-2-Methyl-6-Phenyl-Hexatriene-1,3,5

1) By hydrolysis of the benzoyl derivative(IV). Several attempts were made to hydrolyse the benzoyl derivative of 1-amino-2-methyl-6-phenyl-hexatriene-1,3,5 in both acidic and in basic solutions. The following describes a typical run:

In a 250 cc. Erlenmeyer flask were placed 50 cc. of 20 per cent sulfuric acid, 0.5 g. of the benzoyl derivative and 120 cc. of alcohol. The flask was fitted with a reflux condenser, and the air swept out by means of a stream of nitrogen. The contents of the flask were refluxed for three and one quarter hours, under an atmosphere of nitrogen. At the end of that time no precipitate

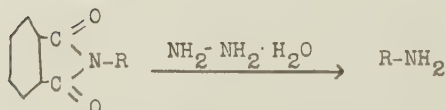
formed when the solution was cooled. Water (250 cc.) was added and the solution was made alkaline with sodium hydroxide and extracted with three 100 cc. portions of ether. The ether extracts were combined, washed with water, and dried first with sodium sulfate and then with potassium hydroxide. Dry hydrogen chloride was passed into a small portion of the dry ether solution, but no precipitate formed. The ether solution was concentrated by evaporation and was tested for the presence of aldehyde, but no satisfactory test was obtained.

2) By hydrolysis of the urethane of 1-amino-2-methyl-6-amino-hexatriene-1,3,5.

Several attempts were made to hydrolyse the urethane (III, p. 4) with concentrated hydrochloric acid.

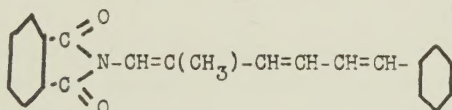
The urethane (7.8 g.) was placed in a 600 cc. flask and over it was poured 75 cc. of concentrated hydrochloric acid. The mixture was heated slowly, with stirring, and then boiled for 15 minutes. The urethane decomposed with evolution of gas and formation of much tar. Water (300 cc.) was added, the solution was cooled and the tar was removed by filtration. The filtrate was made alkaline with sodium hydroxide and was extracted with three 100 cc. portions of ether. The ether extracts were combined, washed with water and dried with sodium sulfate and then overnight with potassium hydroxide. Dry hydrogen chloride was passed into the ether solution, but no precipitate was formed. There was no appreciable amount of residue left when the ether was evaporated. The tar was examined by dissolving it in ether, drying, and saturating with dry hydrogen chloride, but no precipitate was formed.

An attempt was made to hydrolyse the urethane by the method of Manske:¹



¹Manske, J. Am. Chem. Soc., 51, 1202 (1929).

The urethane (0.50 g.) and phthalic anhydride (0.44 g.) were mixed thoroughly and the mixture was heated in an oil bath to 225° until evolution of gases ceased. The time consumed was about 25 minutes. The mixture was cooled to 100°, a small amount of alcohol was added, then an excess of sodium bicarbonate solution. A tarry precipitate was formed which was brought on a filter and washed well with water. This solid was found to be very difficult to purify by crystallization, but by dissolving it in acetone and allowing the solvent to evaporate partially some yellow crystalline matter was obtained. This substance was crystallized from acetone-water and about 5 mg. of a light yellow solid, M.P. ca 200°, was obtained. The nitrogen content found by micro combustion was 4.23 per cent, and the theoretical for the compound



is 4.44 per cent. This method of attack was abandoned because the very high temperature necessary for the reaction resulted in extensive decomposition.

3) By treatment of the acid(IX) with hydrazoic acid.

Five grams of 1-carboxy-2-methyl-6-phenyl-hexatriene-1,3,5 was dissolved in 30 cc. of concentrated sulfuric acid. The temperature rose to about 40° and some sulfur dioxide was formed. The sulfuric acid solution was kept at 40-45° and to it was added 13 g. of a 10 per cent solution of hydrazoic acid in chloroform. The solution was kept at 40-45° until the evolution on nitrogen ceased, and was then poured onto ice. A brownish solid formed which dissolved when the solution was made alkaline with sodium hydroxide solution. The alkaline solution was steam distilled until 200 cc. of distillate was collected. The distillate was salted out with sodium chloride and was extracted with two 100 cc. portions of ether. The ether extracts were combined, washed twice with water, dried with sodium sulfate and then with potassium hydroxide. The dry ether solution was saturated with dry hydrogen chloride and a small amount of white precipitate was formed. This solid was brought on to a micro filter and washed with anhydrous ether. The solid, which weighed about 20 mg., was dried over night in vacuo over concentrated sulfuric acid. The melting point of the

solid was 190° , and the nitrogen content was found by micro combustion to be 10.96 per cent. Some aniline hydrochloride was prepared by dissolving aniline in dry ether and passing in dry hydrogen chloride. The melting point of the compound so prepared was 190° , and a mixture of this known aniline hydrochloride with the unknown substance melted at $188-90^{\circ}$. Aniline hydrochloride contains 10.8 per cent nitrogen, and its melting point when pure is 198° .

The hydrazoic acid solution was prepared as described by von Braun.¹

SUMMARY

In the course of this investigation the following new compounds were prepared:

- I. The hydrazide of 1-carboxy-2-methyl-6-phenyl-hexatriene-1,3,5.
- II. The azide of 1-carboxy-2-methyl-6-phenyl-hexatriene-1,3,5.
- III. The ethyl urethane of 1-amino-2-methyl-6-phenyl-hexatriene-1,3,5.
- IV. The benzoyl derivative of 1-amino-2-methyl-6-phenyl-hexatriene-1,3,5.
- V. The sym-di-substituted urea.
- VI. The hydroxamic acid of 1-carboxy-2-methyl-6-phenyl-hexatriene-1,3,5.

Attempts were made to prepare the amine ($\text{C}_6\text{H}_5\text{CH}=\text{CH}-\text{CH}=\text{CH}-\text{C}(\text{CH}_3)=\text{CH}-\text{NH}_2$) by hydrolysis of the urethane(III) and by hydrolysis of the benzoyl derivative(IV). These efforts did not result in the isolation of the amine.

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¹ von Braun, Ann., 490, 125 (1931).

